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Rooting Habits of the Date Palm

By Linton T. Simmons

CONSIDERING the importance of the root system to the growth of the plant, it is remarkable how little accurate information we have on the rooting habits of the palm. The root system of practically every important horticultural plant except the palm has been described in detail in numerous books and bulletins. The citrus farmer does not have to theorize on the structure or habits of the citrus root. He can find out from a dozen different sources the effect on the growth of roots of soils, fertilizers, alkali, underground water, etc.

So far the grower of dates has been forced to secure most of his knowledge on the rooting habits of the date palm from personal experiences and these experiences have often proved costly because the right conclusions were not deducted from the results obtained.

In discussing the root system of the palm certain characteristics of structure and growth are known to be true of all monocotyledoneous plants. The palm has no cambium layer. Instead of a cambium layer or definite ring of growing tissue we find the vascular bundles scattered throughout the stem. This lack of cambium layer means that the palm cannot be grafted or budded and that the palm stem does not increase in size from the outside which precludes the necessity of bark. The roots of a monocotyledon are directly connected with the vascular bundles found in the stem and a tree may have as many roots or rows of roots as there are vascular bundles.

A peculiarity of roots is that they differ in structure much less from one another than do their stems. The young roots of a monocotyledon have very nearly the same structure as a dicotyledon. As the roots grow older they take on more the form of their stems.

As the plant grows the roots increase in length by multiplication and enlargement of the cells just behind the root cap. We may regard the root cap as a greatly thickened and somewhat modified epidermis which ensheathes and protects the terminal part of the root for a considerable distance. When the root forces itself through the soil the outside cells of the cap are destroyed and are renewed from the interior by the lateral growth.

Plants depend on the roots for the absorption from the soil of water and substances in solution, which are transplanted through the roots and stem to the leaves to be manufactured by certain cells into food material. The main part of the root does not absorb food material but the absorption is by specialized feeding roots. These feeder roots are only found near the tip of the young roots and are short lived.

The absorption surface of the root is increased many fold by the feeding roots. To get such a surface without root hairs would mean the development of a root many times as long as the present root.

Knowing that the feeding roots grow near the root cap and that the roots of a mature tree are from 10 to 40 feet long it is easily understood why the cutting off of the root tips by deep plowing materially reduces the absorption area of the roots near the surface and seriously hinders the growth of the root system. In soils where the water table is near the surface and the tree shallow rooted deep plowing will set back the growth several seasons. It is well to remember where the greatest feeding area of the roots is found. This is where there are the most young roots and extends out from the tree as the tree and root system grows. In a mature date garden this area is several feet from the stem of the tree. When applying fertilizers that are readily available the date farmer should apply it to the greatest accessible root feeding area.

Several men have made limited investigations to prove or disprove some theory they have formulated on the root growth of the date palm, but there has not been an extensive or comparative study made of the rooting habits of the palm under different soil or moisture conditions. I believe many problems of trees dwarfing and dying from no apparent cause would have been solved if the roots and surrounding soil and moisture conditions had been studied.

We do know that the root system of the date palm is extensive. At the University of Arizona date orchard located near Tempe, Arizona, Dr. J. Eliot Coit and Mr. F. H. Simmons followed a root down to hard pan which was 7 feet 3 inches below the surface and then traced the root laterally on top of the hard pan 27 feet 3 inches. They found that the date root can endure underground water for many months at a time without injury and that the roots in water are as healthy as those in the soil above the water. Mr. Simmons states that the water stood close to the surface during the 1914 and 1915 seasons and that he found all the roots alive, healthy and filling in most of the space between the rows. A distance of 25 by 30 feet.

Mr. D. W. Albert, assistant horticulturist of the University of Arizona, states that investigations made by them last summer at Tempe and Yuma orchards show that before the water table was lowered by drainage the roots did not penetrate into the underground water for any great distance but that the roots in the water were alive. Since the water table has lowered they find that the root system is following the water table down so that at the present time the new roots are 10 to 14 feet below the surface. At the Yuma orchard the majority of the roots are in the third to fifth foot with very few roots in the first two feet. The roots in the Yuma orchard like those at Tempe were found to be growing in the water to some extent.

A hole dug near a mature Deglet Noor at the U. S. Date Garden at feet. Taking a rough but conservative average from these figures I have estimated that the roots of the mature date palm in good soil use about 1800 surface feet of soil which allows only 25 palms to the acre if the roots are not allowed to intertwine. Comparing the cubic feet of soil used by the roots with an acre of soil 25 feet deep I find that an acre will support 36 trees. I am not giving these estimated figures to prove that you should plant 25 or 36 trees to the acre as we all know an acre will support trees with their roots intertwined providing the soil fertility is maintained. Just where the maximum results can be obtained

is hard to say, but I do wish to call your attention to the fact that the root system of the palm is more extensive than most of our well known varieties of commercial orchard trees. Therefore palms should be planted farther apart.

A remarkable and interesting thing is the longevity of date roots after the death of the tree and offshoots. As far as I know this has no practical value and likely does not happen except in certain cases. Nevertheless it is interesting. At the Balance ranch near El Centro stumps of old seedling palms burned nearly to the ground when dug up two years later had many live healthy roots and some green leaf bases. At the Yuma Experiment Station live roots were found in the ground four years after the death of the palms and offshoots.

It is usually conceded that the palm root system is more extensive in sandy soil and that the tree bears fruit earlier. To offset this statement some observers say that the palm will live longer and is a more profuse bearer in heavy soil. Whether of these statements are accurate can only be proved by systematic research.

DISCUSSION

Dr. Faries: The remark was made last year at the Institute that the date palm sheds its roots. This started a question in the minds of several of us, and we have been watching the roots ever since. Wednesday I took two men and went to an orchard where I knew there had not been sufficient irrigation for the amount of palms and we dug up six palms, anywhere from 9 to 13 inches in diameter. On these six palms I found two dead roots, one on the palm belonging to it properly, and above this dead portion there was another living portion from which came two small roots living.

On another palm I found two dead roots, but I know that same had been dead for two years, for if you have been digging roots much you can tell when you see them about how long they have been dead. These might have come from another palm in another row, and there was also a possibility that they might have been cut by a plow.

I counted the roots of one of these palms about a foot in diameter. There were 390 roots on it and I think the others average about the same number of roots. Of these 2,400 roots I found two dead ones, so I think we can hardly agree with the men who state that the date palm sheds its roots.

Mentioning the depth to which roots go, we probably all know that the palm root runs down at an angle, for at least twenty-five feet, as the previous speaker has said, the angle of the root, maintaining the uprightness of the palm. These roots that go down send smaller roots up and these seemed to go toward the irrigation ditch. You do not come upon any large roots until you go down very deeply. You know when you plow you come upon small, thin roots going down at various angles and sending up feeders, so that the roots proper are protected from animals, the plow, etc. Wherever they find food these feeders take it to the lower part, sometimes going to a very great depth, and then take it up again to the body of the palm.

We find a mass of what we call aerial roots around the base of an old palm. In cutting this, we find that it is almost as dense as the bunches of fibre in the palm itself. This fibre becomes more dense at the surface, so that after you cut through three or four inches you are in loose soil and many separate roots.

We are also interested in the rooting of the offshoots. This specimen is rather a peculiar one. The root came off of that offshoot and ran around under the fibre to the extent of reaching another offshoot 15 or 18 inches away. This is also the way it goes into the fibre itself and feeds. That was about a foot above the ground and yet it gives us a picture of the way roots feed. This was cut off in the experiment as it is always my method to remove the supporting leaves, so that the roots at the base of the offshoot have a chance to escape into the soil. The advantage of putting manure about the base of an offshoot is to rot this leaf and hasten the decay; that is why deep offshoots are better rooted or more readily rooted because the basal leaf has been dead for a long time and has been rotted and utilized by the roots that have been furnishing their quota of nutrition to other offshoots.

Dr. W. T. Swingle: We cannot discern the root hairs because on date palms they are not as obvious as on other plants. As one of our date growers said, we have very little literature along the line of large monocotyledons and I am sorry to say that this has been very much neglected and that we have very little scientific information regarding root habits of dates. The last two years we have been particularly interested in this question of roots and find that most of the literature is about 75 to 100 years old,—way back in the 19th century France, Germany and England became extremely interested in the root habits of the monocotyledons. These papers are hard to understand because of the difference in terminology. We need some one to work on the root habits of the palm because all of the members can see that the question of root formation is of vital importance. Digging down three feet from an orange tree and you will find roots as big as your arm. There is nothing of the kind true of dates, their roots being about the size of your finger. A Los Angeles man stated that he followed a root for 147 feet to the end of his back yard. It is for the date growers themselves to find out the facts.

Question to Dr. Swingle: Is it correct that a nematode has been found threatening the date palm?

Dr. Swingle: You know a medical student as he reads gets all the diseases the text book describes and so we won't become exercised over the nematode. We know of many date palms having very serious infestation of nematodes when dying. Is it because they are dying and weak that they become infested, or are they dying because the nematode kills them? Last year I found two roots badly swollen from this nematode, but it is my personal belief that the nematode will not injure a good sound palm.

Prof. Hodgson, Chairman: I might add a word on nematodes. They are a very serious pest, but it is hard to demonstrate just what their status is. In 1908-09 a serious infestation of nematode was discovered which appeared in citrus orchards and ever since I have found trees affected by this nematode. Up to the present time no one has been able to prove that this is a real detriment. I have never yet been able to convince myself that a tree has died from an infestation of the nematode. Consequently my own personal reaction would be not to get excited about nematode infestation, although it ought to be investigated.

Howard Ames: I want to know what becomes of the vascular bundles after the date leaf is severed. It looks as though root bundles had come up and intertwined and the crown leaves had come down and intertwined.

Prof. Swingle: These do run to the roots, but they connect both ways so that the root connections are not broken, except in a very few instances. These branch roots do make a network to the leaves and roots in such a manner that they seem like a regular switch-yard.

Dr. Faries: In my own orchard I haven't plowed for several years, but use a disk. I find it advisable to put in a cover crop. The other day I was digging in a long basin in which I have a dozen palms. The soil in this basin is never disturbed, the water being turned in and flooding the basin of 12 trees. This basin through the years has gradually accumulated a mass of dead leaves and vegetable mold and I presume that this mass of rotten leaves on the surface would be utilized by the feeding roots, but there was a space between the rotting vegetable mold and the roots of the palms. We went down a couple of feet with the soil auger before roots were noticeable. This shows that the large roots are all down deep and the smaller ones come up near the surface. I noticed on these little rootlets some white appearing spots, and that is all I have ever seen that I could call root hairs.

Linton T. Simmons: The roots I referred to are the very small rootlets you find on the feeding roots.

Bruce S. Boyer: It occurred to me from the description of real roots and their habits of growth that in sending up their feeding roots from the lower trunk roots that they cover all the surface of the ground, and that fertilizer may be well distributed.

Cold Storage of Dates

By Leonhardt Swingle

FROM experiments carried on by the Deglet Noor Date Growers Association in 1924 and 1925 in the use of cold storage in a commercial way, we have come to believe that cold storage is to play as vital a part in the handling of the date crop of the Coachella Valley as it does in many other agricultural crops. In the past, cold storage has not been used to an appreciable extent by anyone, so it would appear that it has been regarded as either unnecessary or actually harmful. Some have gone so far as to say it was harmful.

It might be well to state at this time, that this paper is based on the experiments and work of the Deglet Noor Date Growers Association conducted in 1924 and 1925 and all statements made are based on the Deglet Noor variety. There seems every reason to believe, however, that the principles involved are applicable to any and all varieties, for the Deglet Noor can be made to resemble a great many different varieties depending on the treatment it receives.

Nor is it claimed that this work of the Association was the first or the only work being done on cold storage. The United States Department of Agriculture has been carrying on experiments on cold storage for several years and their work is still in progress. The Arizona Experiment Station has reported on cold storage with the dates of the Tempe garden. The Deglet Noor Date Growers Association tried it on some of their fruit in 1920 with unsatisfactory results. Probably everyone concerned in the handling of dates has at some time or other conducted experiments in the use of cold storage.

In the 28th annual report of the Arizona Experiment Station there is a report of some experiments on dates of different varieties placed in cold storage in Phoenix on September 20, 1916. It shows that one variety spoiled almost at once, that most of the fruit kept perfectly for about five months, and at the end of a year, all showed strong tendencies to be stale or mouldy. This work was carried on before most of the date gardens of the Coachella Valley were planted, and while as a whole the results were satisfactory, the three conditions that developed—prompt spoilage in a part, mould, and a stale taste—have appeared time and again and have been sufficient to discourage much work on cold storage.

The Deglet Noor Date Growers Association inaugurated a series of tests in 1924 to attempt to utilize cold storage in a commercial way. The aim in all this work was the commercial use of the cold storage facilities that exist in all important markets. The viewpoint was strictly commercial in that the endeavor was to utilize the facilities that now exist, rather than to attempt to develop new methods.

The Association was led to undertake this work by the constantly increasing crop of Deglet Noor dates that has led to two problems, first, the heavy receipts during the peak of the season, and second, the need of storing the packed fruit. Do not overlook these two points. First handling the fresh fruit during the height of the season which is a packing problem, and second, storing the packed fruit, which is a marketing and selling problem. Let us divide this paper into two parts and consider first, cold storage of the fresh fruit, or in connection with packing.

When several varieties are handled no doubt the dates would not have such a strong tendency to all ripen at once, but with the Deglet Noor, the record of receipts show that from 15 to 20 percent of the entire crop is received at the packing house in one week, and very nearly half the crop comes in three weeks. Furthermore, these heavy receipts start within a month after the first dates are received. Dates cannot be packed out just as received, but must go through a process of ripening, curing, and drying before they can be packed and it is not possible to do this work with unskilled labor.

In the packing house it has meant very strenuous work to handle this peak so near the start of the season while the packing house force was still new. Later in the season, when the crew had acquired skill, the rush was over and the dates were all gone. With an increasingly large crop, it has meant a very big packing house and the packing of the crop by hasty and unskilled methods, or the use of cold storage for the fresh fruit. With a small crop these tendencies are serious enough but with a crop the size of that in view for the Deglet Noor Association within a few years, it becomes a serious matter.

It was for this reason that some samples of fresh fruit were placed in cold storage in Los Angeles on November 20, 1924. They were stored at 33 degrees in the driest room available at that temperature. There were two lots of ten pounds

each of freshly picked fruit. They were selected so they were uniformly as green as the Association had been receiving. This means Deglets showing a little pink and with abundant "rag" and tannic acid.

Quoting from a report made to the Board of Directors on June 20, 1924. "On January 5, 1925, we examined one of these cases and found it had ripened completely, was of fair flavor, some rather soft and sticky but none soured or mouldy. On February 17 we examined the other case. It had ripened soft, no fermentation, rather opaque in appearance."

The satisfactory and thorough manner in which the ripening had taken place was very much of a surprise to us and opened up a new viewpoint in the handling of dates, for remember, that this fruit was as green as is ordinarily picked. It was full of rag and tannic acid and not edible when placed in cold storage. We believed that one of the main factors in this ripening was the deposition of the tannic acid by cold instead of heat or chemicals. To test this point, on January 9, or immediately after opening the first case, a three pound can of very green unpollenated fruit was sent to the cold storage company with request that it be kept at a temperature of 10 degrees F. for one week and returned to us. Our request was carried out and on receipt of the dates we found as we had anticipated, that the tannic acid taste had entirely disappeared from the green fruit. Unpollenated fruit was used merely because it was all that we could find at that season of the year that was green enough for the experiment.

This method of removing the tannic acid by cold we believe to be entirely new and previously unreported. It was an entirely unlooked for discovery, the end and practical use of which we do not yet see. It has no resulted in any change of plans or methods of handling the dates in the packing house as yet, but it has nevertheless helped up in solving a number of problems.

The first question that arises in connection with these dates, is that since they were November dates which are ordinarily considered the best in quality, perhaps earlier fruit would not ripen so satisfactorily. In order to test out this point, other samples of fruit were taken in September, 1925, and likewise placed in a temperature of ten degrees F. for a further test.

These were September dates that are usually considered to be of poorer quality than those ripening later. They had only the tip showing translucence, the rest of the date being still hard and firm. They were of average size and seemed of ordinary good quality. They were greener than dates are received at the packing house. After being kept in cold storage for about two weeks they were returned for examination. They had ripened just as the November dates of the year before and were very good, although much too soft to pack. The tannic acid had all been deposited leaving all of the sugar and flavor of the fresh fruit.

This deposition of the tannic acid by cold brings out plainly certain things that other methods of ripening fail to show. First, that while green dates can be ripened into an edible product, they do not yet possess their full quota of sugar. The analyses of Dr. Vinson of the Arizona Experiment Station confirm this and clearly show that the sugar increases in a date as long as it is green. While it is possible to ripen dates that are very green, they do not yet contain enough sugar to make good fruit. In other words, they can be ripened but are not worth it. The stage at which they are usually picked, or as the date becomes translucent and while still full of rag, combines the maximum sugar and flavor without having ripened so far as to become a darker and drier product.

Again this work shows that there is no inherent difference between September and November dates due to their difference in ripening season. First class September dates are just as full of sugar and flavor as the dates ripening later. Remember, however, that this does not hold true for the very first dates that ripen prematurely on the bunch and also, that much of the early fruit is undersized and shrivelled, ripening early due to lack of food and water. Such dates are of necessity inferior, but good sized and well developed September dates have just as much sugar and quality as those ripening later.

Due to the temperatures prevailing at the start of the season in the field, while in transit, and in the packing house, the ripening is carried on at high speed and is not under such favorable moisture conditions as later. It is clear that the early dates must be picked oftener and watched closer than later in the season, but if they can be held under as favorable ripening conditions, will make as good dates.

As was stated before, this method is still undeveloped, but the fact that green fruit of good quality can be placed in cold storage at very low temperatures without deterioration in quality, gave the Association confidence last packing season to place 40,000 pounds of unpacked dates in cold storage during the peak of the season. Though not as green as the dates just discussed, and much drier, they were still only partly cured. They were placed at a temperature of 32 and held for about two months and when the packing house was through with the fresh fruit they were brought back, graded and packed. The results were a complete success. The dates had dried slightly but were in perfect shape. Under no ordinary storage could they have been held so long unpacked without drying out or deterioration in flavor and without great danger of insect infestation. The ability to handle the peak load of the season was of very great benefit to the Association under the conditions prevailing last fall. We feel that as an aid to packing house methods, cold storage has already proved its worth and intend to use it to an increasing extent in the future.

The second phase of cold storage to be discussed is the storage of the packed fruit. While of course this problem has always been present, it becomes of more and more importance as the size of the crop increases. With a small crop, it has been possible to put in the hands of the consumer the dates as fast as they were packed, but as the pack increases, it becomes necessary to store some of the fruit before shipment to dealers and consumers. It is of vital importance to all concerned that the dates suffer no lowering in quality from the time of packing till they reach the consumers' hands.

To test commercial cold storage for the packed fruit, the Association sent to the cold storage plant in Los Angeles different packages and grades on November 20, 1924, along with the fresh fruit previously described. They were stored at a temperature of 33 degrees in the driest room available, or that in which dried fruit is ordinarily stored. Samples were returned from time to time as called for and examined. The results were highly satisfactory in all cases. There was no loss in weight, change in color or flavor, or deterioration in any way. Again quoting from the report made to the

Board of Directors; "June 6th, 1925, we received cases Nos. 8 and 9. After about 6½ months storage at 33 degrees F., the dates in the cardboard cartons as well as in tin were found to be in fine condition. The Desert Gold brand had retained its color and flavor almost perfectly and both Desert Gold and Golden Valley brands were in a moist condition with, in most cases, no loss of weight that could be detected. The Desert Sweets were also in apparently perfect condition."

An analysis of this experiment along with certain unsuccessful work such as the results of the Association experiment in 1920, shows, that aside from the problem of insect infestation, stored dates suffer from drying souring, mould, and loss of flavor. All these evils were avoided in our recent work with cold storage and it is well to consider why.

Consider the first, or loss of weight. Dates are extremely sensitive to moisture and will absorb or lose water with great rapidity as the air around them is moist or dry. If, therefore, kept too moist, the dates will absorb water which may lead to souring if the dates were already moist, and certainly leads to a darkening of appearance and loss of flavor.

On the other hand, if kept too dry, to guard against this danger, the dates lose in weight and become hard and unattractive in appearance. The margin between these two evils, or the factor of safety, is very narrow under ordinary storage.

Cold storage rooms are of necessity insulated, and have the air under control at all times. It becomes a much easier task to keep the air at the right moisture content. In practical work this means a dry cold storage as most cold storage is inclined to be too humid and this has been one cause of the darkening in color and loss of flavor in the past.

It is plain that any room that has the humidity under control would store dates as far as the moisture factor is concerned and also many packages are more or less air tight, so the question promptly arises, why not store at temperatures of 40-50-60 which would be much cheaper?

Many chemical changes occur during the ripening of the date but the most noticeable is the deposition and change in character of the sugar. There is a whole chain of processes running through cane sugar, invert sugar, alcohol, and vinegar. The cane and invert sugars, alone, or in mixtures of varying proportions as the case may be, have a great deal to do with the characteristic date taste that we associate with the different varieties.

In the Deglet Noor variety, the characteristic flavor and quality are developed near the start of this chain of processes and to allow the disappearance of the cane sugar is to suffer a darkening in color and loss in flavor. All this chemical action is caused by enzymes that will work right along under conditions of ordinary storage but very low temperatures render them inactive. A low temperature will, therefore, stop this chemical action and the flavor and appearance can be kept without change if the moisture is at the same time controlled. Perhaps such a low temperature as 32 is not always needed, but in commercial work it is very easy to say,—use cold storage at 32. This temperature is already available and in use and as stated at the beginning of this paper, the object of the test was to use facilities that already existed.

A very serious danger in storing dates is mould. Moulds are especially liable to occur in dates low in sugar and full of moisture. They will develop very rapidly in temperatures in the thirties and if the dates are full of water, storage seems to actually stimulate mould. This trouble is more a danger of the fresh fruit and whenever dates are cured so they are relatively dry and rich in sugar, mould does not bother. Keeping the temperature and humidity down to a low point while the dates are in cold storage, is the best means of prevention and such storage is worth considering for this point alone for of all troubles that affect dates, moulds are the worst. In neither the cold storage of the fresh or packed fruit have we suffered from mould and we hope never to be troubled with it.

Another source of trouble is the development of a stale taste. Sometimes the dates do not lose sugar, do not mould, and do not sour, but have a decidedly stale, unattractive taste. Keeping the air around the dates fresh and pure seems to be a sure preventative. It may be well to say here that cold storage is not the only place this condition may occur, as it is just as apt to happen in ordinary storage, or even in the maturation room, but it always seems to be associated with stagnant air and fresh air is a sure preventative. In the cold storage rooms in Los Angeles, the rooms were treated with ozone and we are of the opinion that this ozone treatment has been responsible for no trace whatsoever of this stale taste developing. Certainly this bugaboo has not appeared in our work.

In fact, in our work with commercial cold storage in 1924 and 1925, about our only trouble has been a lack of dates to put in cold storage and we expect that to be remedied this year.

As an example of what the use of cold storage in marketing means, there was a customer in Maine that wished to place an order for a case of Golden Valley dates every month. A supply was put in cold storage with instructions to ship a case each month to this person. We asked the buyer to let us know if the quality help up, as this was something of an experiment and we were much interested in the results. The dates were shipped, a case each month, all through the winter, spring, and into the summer when the supply of dates gave out and the customer reported the last dates to be in perfect condition and was ready to order again the next year.

This means that our date crop does not have to be picked, cured, packed, sold and consumed in a few months' time. It means making a year round fruit out of the date which has not been possible heretofore. This should benefit the grower, the retailer, and the consumer. The grower does not have such a packing and selling problem, the retailer can keep his supplies over a longer time and has a chance to work up a year round demand for his dates, and the consumer can be assured of getting his dates in first class condition. The whole field of selling the date crop and getting it in the hands of the consumer has a different appearance when cold storage is considered as part of the problem. It has already changed the viewpoint of the Association in many matters and we expect it to work even greater changes in the near future.

It would probably be a good idea before closing to mention a few things that cold storage will not do. It is a good thing but it will not do everything.

In the first place, it will not kill the bugs. If insects are present in the dates when they are placed in cold storage, they will simply hibernate and awake with renewed appetites as soon as the dates are removed. This is speaking of the use of low temperatures, for at higher temperatures, they may go right on developing. Certainly neither the

insects nor their eggs are injured in the least by a temperature of 32. The control of insects in the packing house is a separate and distinct problem.

The second thing to remember is that cold storage is in no sense a substitute for careful packing. If the dates are mixed as to quality and ripeness when stored, they will still be mixed when removed. In fact the extension of the season means more careful packing and grading. Dates may be stored ungraded and unpacked for treatment afterward, but we cannot substitute cold storage for grading and packing.

And in conclusion remember that dates are very sensitive to odors and must be stored with dates. We can store the dates with other things if we desire and have them taste like apples, potatoes, onions, or anything else we desire but there is nothing better than the natural date taste and to keep it, dates must be stored by themselves.

DISCUSSION

After the reading of Mr. Leonhardt Swingle's paper on "Cold Storage of Dates," the following discussion took place: Mr. S. B. McMillan told of some experiments which he had performed, and said, "After deciding to make some experiments along cold storage, I tried some seedlings and some Deglets. Realizing the uncertainty of how these dates would come out of cold storage, I knew that I might lose all or save them all. However, I was very pleased with the results. After having put them in cold storage, I looked at them in three weeks time. They had kept all right till then and did keep all right up until the time I took them out, which was after seven weeks. I had a number of named varieties and as I said before seedlings. After taking the dates out I noticed that they had the taste of apples, near which they had been stored. This flavor, however, disappeared entirely about ten days to two weeks after they had been taken from cold storage. These dates were put in pound baskets instead of being packed. They were not handled at all until they were taken out, and this was a decided advantage for the soft varieties. We had only one date that soured; and there were many that would have soured had they not been put into cold storage, but they came through finely. They held their shape very well, but lost about 20% in weight, and I believe the cold storage date will be the only salvation for dates on the Los Angeles market, as they do not move very fast. The temperature we had for these dates varied from 32 to 26 degrees. It was not constant however. We did suffer a little loss from mice. I had some discussion as to whether the dates were wormy or whether it was date sugar that had developed on the outside of these dates. We learned, though, that these dates had a very large percentage of sugar. They tasted all right, but some did not look so well on account of sugar deposit on the outside.

Mr. Cameron gave a short talk as follows: In a general way I made some experiments using a number of varieties of dates, with some soft varieties. We experimented with four different temperatures, i. e., 32, 36, 45 and 60 degrees. The Deglets kept well at temperatures of 32 and 36. The soft varieties had a tendency to sugar. It was more noticeable at the higher temperatures, and some varieties sugared some at the temperatures of 32 and 36. These studies were, however, merely preliminary and should be followed up by other tests. We experimented with some immature dates, but the results were very unsatisfactory, and were not in any way conclusive.

Mr. R. H. Postlethwaite stated that Mr. Swingle had opened up a number of interesting points on this line, and at some future date it would be interesting to discuss this problem at length. However, he wanted to issue a warning at this time to date growers to the effect that he did not think it was necessary for cold storage to be considered too seriously, i. e., he did not want the growers to spend too much of their time considering this phase, as it was his belief that the cold storage idea was not as necessary as some might believe. He spoke particularly of other fruits that needed cold storage, but said he did not believe this applied generally to the date. Fruits which had considerable cellose dry very rapidly after being taken out of cold storage. Just a few words to make you think. Do not put your money into cold storage plants. If the fruit can be kept without cold storage, and I believe it can, I believe it will be much better. My present opinion is that cold storage is only a makeshift for improper packing, and I hope that next year we can have a thorough discussion of the packing and processing of the fruit.

Dr. W. T. Swingle remarked that the Christmas dates, especially the Deglet Noor might be better for cold storage, though he did not want to make any specific statements regarding this. He said the dates of England and Spain are not kept by cold storage, yet they keep perfectly and are in good condition in grocery stores.

Mr. F. H. Simmons remarked that some experiments had been performed on the Rhars. They kept for a time, but spoiled in about three months.

Mr. Hayes of Indio: We started packing dates on October 1st and have attempted to market only a few. I have kept dates in the refrigerator at temperatures of between 50 and 60. At present the temperature is between 60 and 70. I did not have any dates spoil, but we were extremely careful to see that all dates were well fumigated. I will be glad to offer the use of my laboratory for experiments to anyone at any time.

Question: Will dates keep longer or a less time after they have been taken out of cold storage. L. Swingle answered: Our observation is that it depends upon the condition in which they were in when they were packed. If good, will keep all right after they come out.

Mr. Cook stated that he had kept dates perfectly for three months after taking them out of cold storage.

The Economic Use of Irrigation Water

By Byron J. Showers, University of Arizona

THE economic use of irrigation water implies a wise and careful management of water. Water must be put to beneficial use to be used economically. Unnecessary evaporation and excessive percolation results in undue waste. Irrigation water cannot be used wisely unless the grower has a definite idea of the

properties of soil and water. He cannot use it carefully unless he exercises due concern as to what it will do and what may become of it. Careful studying must be substituted for guessing.

Soil and Irrigation Relationships

1. Water carrying capacities of soils:

All soils have a field carrying capacity. Soils are plant water and plant food reservoirs. In general, the soils in which dates are grown in the Southwest will carry from 6 to 30 per cent moisture. Naturally the sands retain less and the clays more. A large part of our Southwestern soils will carry from 14 to 20 per cent moisture. As a general rule, 1½ to 2 acre inches of water will increase the moisture content of an acre foot of soil from the wilting point to the field carrying capacity. In other words, it will usually take from 1½ to 2 acre inches of water to wet an acre foot of dry soil. If 1½ acre inches per acre are required to wet the first acre foot of soil, four times 1½ or 6 acre inches per acre will wet the same type of soil to a depth of four feet. Likewise, it will take 9 acre inches per acre to wet the same soil to a depth of 6 feet.

The quantity of water put into a given soil usually determines the maximum depth of penetration; while the quality of water, soil texture and soluble salts present govern the rate of movement.

Ground water will affect the carrying capacity of a soil for a distance of three to six feet above the water table. This rise is caused by capillary movement and is known as the capillary rise from a free water surface and must not be confused with capillary rise from a moist soil.

2. Soil moisture movement:

Soil moisture tends to follow the force of gravity—downward. However, capillary forces and evaporation tend to draw soil moisture upward. Capillary works in three directions — down, up and laterally. The battle results in a movement in all directions, but approximately two and a half times as fast downward as upward. In a specific soil the vertical rise from a free water surface will be approximately four feet, while the vertical rise from the moist soil will be only a foot. Alkali and stiff clay soils resist the movement in all directions. The distance that soil moisture will move laterally is usually very short, seldom over one to one and a half feet. In general, with a given soil, water penetration is proportional to the wetted area. Deep furrows usually give a deeper penetration than shallow ones.

3. Conditions governing the application of irrigation water:

Water should be applied in various ways with different types of soils. Information previously discussed will be of value in making this determination. A general policy of lighter and more frequent irrigations on a sandy soil will necessarily have to be made than on an adobe soil, since the lighter soils have a lower water-carrying capacity. A sandy soil will take water faster and give it up to the plants more readily than a heavy soil. Soil surface evaporation and deep percolation will be greater on a sandy soil than on a heavy soil. Capillary moisture will not move as far in a sandy soil, but will move faster than in a clay soil. A heavy soil is more likely to bake and crust than a sandy soil. Organic matter will improve the tilth and increase the water carrying capacity of soils. An alkali soil will not take water as fast as a non-alkali soil. A soil containing black alkali will be tighter than one containing only white alkali salts. Some writers have tried to place a definite limit upon the maximum quantity of alkali salts a soil or water may contain. Late investigations indicate that these limits were too narrow. Such factors as soil texture and character, and the character of the salts in the soil and water play too great a part to place a definite toxic limit. If a soil has good drainage, and the irrigation water is applied judiciously, it appears that very saline water may produce good crops. A soil may be badly alkali and yet strong alkali water may be used to reclaim it. It may, also, be better to continue the use of this alkali water than to discontinue it, for bad after-effects may result. In fact, alkali waters of certain characters may more readily penetrate and thereby leach an alkali soil faster and more completely than pure water.

Alkali reclamation is dependent upon 1, the effectiveness of drainage; 2, texture of the soil; 3, soluble salts in the soil; 4, quantity of water applies; 5, quality of water applied.

The irrigation slope of a sandy soil may be greater than that of a heavy soil. Land should have a fall of from one to four-tenths of a foot per hundred feet. The heavier the soil the more nearly flat should be the run.

Irregular and rough ground result in irregular distribution of the irrigation water and uneven penetration. Uneven water penetration means the waste of either land or water, and some times both.

The length of the irrigation run, next to canal seepage, is the most important factor underlying the waste of water in the Southwest. Low labor costs to handle the water and plenty of cheap water to waste have been the main contributing causes. If water is scarce or more expensive than land, it should not be wasted. The Southwest cannot develop its land and water resources unless its water can be appropriated for beneficial use.

I do not wish to be understood as advocating a generally less shallow water penetration, but to discourage unnecessary leaching at the upper end of long irrigation runs. Fear of the results of light irrigation application and shallow water penetration may not be amiss for all of our irrigation waters contain some salts in solutions.

Occasionally an irrigation system is so laid out and operated that the irrigation water penetrates only a foot or two into the soil and therefore does not carry the soluble salts away. Instead of the water carrying the salts downward and out of the root-zone, the water evaporates and leaves the salts contained in the irrigation water plus the salts originally in the soil. Although very little attention has been given to water penetration under irrigation in the West, it appears that a soil to be used successfully for the production of crops, under irrigation must be readily permeable to water. It is important that in practice sufficient water penetration should be obtained, not only that the soil may act as an adequate reservoir to store water for plant use, but also that any excess of soluble salts may be leached downward and out of the root-zone.

"It does not seem necessary that this downward movement of water should be continuous or that any large proportion of the water applied to the soil should pass into the water table. But it does appear certain that occasionally some water should pass on. Unless some of this irrigation water passes on, it is inevitable that in time—either near or remote — the soluble substances brought in by irrigation water, together with those set free by soil disintegration, must accumulate to the point of harmfulness. Thus it may be said that for continued successful irrigation farming there must be a cumulative downward movement of water through the soil.'

With a given soil water penetration is proportional to the length of time the water is on the land. For example, if it takes a certain sized head of water three hours to reach the lower end of a quarter mile run, and is then shut off, a point fifty feet from the ditch will have been covered with water for three hours while the lower one-third will have been covered for only one-half hour. It can readily be seen that unless the soil actually seals up, a greater penetration would be obtained at the upper end than just above where the water accumulates at the lower end. Even though this difference might only be one or two feet, and it often is much greater, one or both of two things have happened. Either sufficient water penetration has not been obtained in the lower one-third of the run and the root development restricted, or excessive penetration and waste of water has been brought about at the upper end. Restricted root development and the waste of water are bad enough, but waste of water by unnecessary penetration results in excessive leaching of plant foods from the soil. Since in the heavier soils, the time factor is not so material and ordinarily no great water loss will be experienced. The economic distance that water may be run on heavy, tight soils is greater than on the more porous soils. It will be readily observed by the interested grower that the major portion of the relatively non-productive spots in fields of one-quarter and one-half mile runs are confined to the lower one-third of the field.

Should it not seem a peculiar coincidence that these spots should be largely confined to the lower one-third of these runs? Soil borings and cross-trenchings have definitely shown that water has not penetrated in these spots to a deph of over six to eighteen inches, while a penetration of from two to six feet has been obtained at the upper end. Six hundred sixty feet or one-eighth of a mile is the maximum distance irrigation water should be run on most of the Southwestern soils, and 300 to 400 feet on many of our soils where dates are being grown.

As a general rule the irrigation heads are too large to be properly controlled. This results in uneven distribution and usually shallow water penetration. If border irrigation is followed the ground should be prepared with the proper fall and leveled completely between borders.

As previously mentioned, soils underlaid with a high water table (free water within 5 to 8 feet) will not need as heavy an application of water as the deeper soils — merely enough water to bring the two wetted areas together. High water tables are associated with shallow rooted plants and may in time mean alkali land.

Our great loss of water in the Southwest is not through soil surface evaporation as is often thought, but leaf transpiration. In general leaf transpiration is proportional to the leaf surface of a given plant.

Water losses from the soil surface will be only slightly affected by the addition of surface mulches. If we think only in terms of the upper 6 inches, then the proportion of water lost from the soil surface is great. If we speak in terms of six feet of soil, then the loss is relatively unimportant. During June, July, August and September large quantities of water may be lost from the surface if this thin layer is kept continuously wet by light, frequent irrigations. The loss in this case is simply one of distillation and not one resulting from capillary movement. The loss may approach 15 to 20 tons per day per acre, regardless of whether the soil has been cultivated or not. A cultivation simply means the surface 2 or 3 inches has been dried out sooner than if it had not been cultivated. The soil moisture in the second, third and fourth feet will not rise by capillarity fast enough between irrigations to justify our considering it as a factor underlying the economic use of water, for there are many things far more important. The evaporation loss from weeds may be very large. Weeds should be kept down especially during July, August and September.

The cost of land, water and labor should be considered. If land and labor are high priced, and there is a surplus of cheap water, it may be economical for a time to use it in copious quantities.

Rate, duration and frequency of water delivery is largely dependent upon the type of soil and the various stages of fruit development.

Careful irrigation management requires a knowledge of the approximate size of the irrigation head. If the irrigation system is so arranged and managed that uniform water penetration can be obtained, the farmer can change gallons per minute into approximate depth of penetration. It is not necessary to measure water on the farm as accurately as the engineer would do it or as he would have us do it. "A chain is only as strong as its weakest link." If we only guess at the water flow, our error may vary from 0 to 200 per cent. The rectangular weir will measure water sufficiently accurate for all practical purposes. The measurements thus made will be readable in terms of cubic feet per second, a cubic foot per second equals 450 gallons per mniute, equals 40 miner's inches, equals an acre inch per hour. Every grower who is using water from a pumping plant should measure his water flow often in order to check up on the efficiency of the plant. He is not using water economically if his pump is not working properly.

DISCUSSION

Chairman Hodgson stated that there were also two more important points to be considered: First, capillary movement of the moisture in the soil, and second, how moisture is lost from the soil. Several experiments are now being conducted by the University of California along the lines of capillary movement of moisture in the soil. For all practical purposes, however, we can eliminate capillary motion of water. Loss of moisture from the soil due to this motion is practically negligible. This is difficult to accept, but the evidence is there, and the experiments have been duplicated on all kinds of soil. Moisture is lost from the soil through plants. Any kind of plants will take moisture from the soil in large amounts. If there are no plant roots the moisture stays there. It is, of course, possible to water-log the soil and cause a gradual decline of the date palms. This is especially true in the case of young palms. Old palms will take lots more water, while the young palms will simply allow more and more water to be piled up around themseves and not use it to advantage. They will, though, stand it better than most fruit trees, but many citrus trees are injured because of this fact, i. e., water-logged, unless weeds are allowed to grow and take the moisture out of the soil. The use of soil augers is also important in determining the soil conditions. The best way, though, to find out is to make borings at the dry season of the year and determine the condition of the soil before irrigating.

When you know that you have wet the soil, then you must determine whether you have done it uniformly. There is only one condition of uniformity, and that is its field carry-

ing capacity. You cannot wet a soil half way as is commonly believed and thus make it dry out. The only way in which air gets into the soil is by the soil drying out. So if you continue to put water on, you merely accentuate any lack of aeration, and therefore kill the roots. This may apply to dates and it may not.

Prof. Albert: Some time ago we were irrigating near Tempe and we had quite a problem on our hands. The first thing we had to do was to get out all of the alkali so that the water would penetrate. By breaking the soil up we finally got the water to penetrate deeper and deeper and finally washed the alkali down. During the latter part of the summer we had the soil in such condition that it would take the water well. Underneath, we found that the roots were growing down and following the water table very rapidly. We dug holes and found that the roots grew down to a great depth. The roots are about the same in heavy and light soil. By putting gypsum on part of the soil we found that it increased the water penetration very much, so that we will have an entirely different kind of soil there.

Dates of Mesopotamia

By V. H. W. Dowson, formerly Agricultural Director of Mesopotamia for the British Government

IT is extremely inspiring for a resident of far off Mesopotamia to see the progress made in the raising of dates in Southern California. Already I have found much of interest and of value in comparing the gardens of California with those of 'Iraq.

'Iraq, which is perhaps more commonly known in America as Mesopotamia, is situated north of the Persian Gulf. Two rivers, the Tigris and Euphrates, rising in the north and emptying in the Persian Gulf, cut through the center of 'Iraq and form its principal water supply.

The Garden of Eden is supposed to lie at the junction of the Tigris and Euphrates rivers some 100 miles from the Persian Gulf.

Dates are the principal crop of the country.

Irrigation is the greatest single factor in agriculture. The history of 'Iraq as far back as there are any records is a history of wars between Assyria and Babylonia for water rights. Whatever tribe or race held control of the northern part of the country dominated all of 'Iraq for the waters of the Tigris and Euphrates could be deflected for irrigation and the southern part left to starve.

Three methods of irrigation are used. These are: flow, lift and tidal. Flow irrigation is used where rivers and canals are above the land level. Lift irrigation where canals are below the land level. This requires the lifting of water to the higher level by machine, animal, or hand power. Tidal irrigation employs the action of the tides in the Persian Gulf which backs up the waters in the river twice a day. By allowing the water to flow in and out of the canals freely there is a minimum of salt deposited and the land is kept sweet.

There may be 30,000,000 palms in the entire country and probably one-half of these are located at Basrah, or to be more exact, on the Shatt-al-Arab river which flows from the junction of the Tigris and Euphrates rivers south 100 miles to the Persian Gulf. In this same region there are about 50 different varieties of dates grown, while in the country as a whole there may be 200, varying in shape, color and time of ripening. In the order of their importance the varieties grown around Basrah are: Saiyir, Hallawi, Khadhrawi, Dairi and Zahidi, varieties whose names I am surprised to hear pronounced so easily by even the children here in California. In the country as a whole Saiyir and Zahidi varieties predominate.

Surface cultivation must be done by hand, the network of canals making machine cultivation well-nigh impossible. Very few horses or cattle are used for ploughing, camels I have never seen but once and Fordsons are used only on cotton plantations. In well-kept gardens, every four years, the land is dug over to a depth of two feet by Arab labor. Three men work together using long-handled, short-bladed native spades. Manure is dug in around the roots of the palms. For undercrops we plant oranges, of which there are many varieties, pomegranates, grapes in abundance, figs, vegetables and alfalfa.

The work of cultivation is made very difficult because of the character of labor. It is hard to get the native to work, and his labor is very inefficient. All hiring is preceded by hours of haggling, for the Arab is a shrewd bargainer, and much coffee and many cigarettes are consumed before a deal can be closed. Women and children cannot be counted on to be of any assistance except at harvest time.

For planting we prefer date offshoots with roots; and we plant them the year round, except in the middle of summer and winter. About 12 offshoots are obtained from each palm and the prices for Saiyir, Hallawi and Barhi offshoots run about 8 cents, $1 and $5 respectively. The roots are dug in as quickly as possible; and, should planting be delayed, the roots are kept in water. The young shoots, after planting, are wrapped around with toolies (reeds) or palm fronds, and watered daily. The palms are planted 100 to the acre.

'Iraq palms have fewer fronds than those in California; and little pruning is practiced, other than to cut off the fronds as soon as they die.

The rate of palm growth appears to be somewhat faster in California than in 'Iraq. In Basrah the growth might be estimated to be 24 feet in the first 20 years, 12 feet in the second 20 years, and so on, decreasing about one-half with each succeeding 20 years until a palm 100 years old will stand some 50 feet high. As the Arabs keep no records, it is hard to determine the ages of old palms with any great accuracy.

It is the practice in pollinating to cut the unopened male spathes; the spines are not cut off so much as they are in California. Much damage is done by the red spider; and the Hamairah moth gives trouble. Of scale insects there are three; but they do not appear to do very much damage, possibly because Aphelinus preys upon them. The Asarcopus has not been reported.

The time of harvesting is always a lively one. At the beginning of the season the principal growers and exporters meet to fix the prices and demand is always keen. When the dates are ripe they are harvested all at once. The bunch is cut off and the fully ripe dates shaken into a basket. The green ones are then left to ripen on the bunch to be shaken off later. The average yield at Basrah runs about 50 pounds per palm but in the well-kept gardens the palms produce as much as 150 pounds. Different varieties, of course, ripen at different times, the Hallawi variety being ready to harvest a week to 15 days before the Saiyir.

After the dates are harvested they are packed for domestic use and for export. Dates for export are packed in boxes weighing about 70 pounds filled, while for the Indian market as well as domestic consumption baskets are used. Skins are not used at Basrah but to the north in Bagdad, where they are more plentiful, they are employed quite commonly for packing. And then following the packing time ensues a period of intense rivalry to get the first boat off to foreign markets.

The United Kingdom and the United States are the heaviest buyers of dates. Last year there were exported from Basrah about 38,000 tons of Saiyirs, 33,000 tons of Hallawis and 11,000 tons of the Khadhrawi variety, while the production around that city might have aggregated some 175,000 tons. For the entire country the production might have been about 800,000,000 pounds. The secondary products of the palm are used to make baskets, to thatch the roofs of native houses, etc.

Now to the American grower of dates, conditions in 'Iraq may seem near to ideal for the cultivation of the palm, but there are many factors which tend to offset these advantages.

In certain seasons of the year, religious festivals make work impossible. One in particular, the Ramadhan, incapacitates labor, for it requires that eating, drinking and smoking be refrained from during a period from before sunrise until after sunset, and this in a climate where the body craves water. The hardship thus imposed on the Arab is not conducive to heavy or constant labor.

Sometimes, wind storms will arise and deposit dust on the dates just when they have become most sticky; but, fortunately, that is not a frequent occurance. Then, too, the government has placed a high duty on importation of machinery and supplies so that the date grower must think twice before ordering up-to-date equipment. The sight of rural homes lighted by electricity, such as is seen throughout the West, strikes the visitor from 'Iraq as unbelieveable; for electricity and gas are only found within the two large cities of Bagdad and Basrah.

'Iraq has suffered much under Turkish domination and it will take many years to repair the decay of centuries. But the future of the county is bright. The country needs capital for development; but, heretofore, there has been little or no security for foreign investors. But conditions are changing and I maintain that great things are in store for 'Iraq, but nothing compared to the great future in store for the Coachella Valley of California.

It is not easy to tell you what this visit to the date gardens of California has meant to me. One's own efforts at scientific work are greatly stimulated by seeing the work of others and it has been a great pleasure to meet your scientists. I much looked forward while I was in 'Iraq to this opportunity to talk with the "father of the date industry" — Dr. Swingle — and to learn from him of New World achievements. It is my hope that in recounting the story of the Dromedary date I have interested you in the Old World so that in the future I may have an opportunity of seeing you in 'Iraq and reciprocating your hospitality.

Observation on Rain Damage to Dates

By H. W. Postlethwaite

THIS paper may conveniently be divided into two sections. The first section will be devoted to a discussion and consideration of the damage resulting from rain to the different varieties of dates grown in the Coachella Valley and the second section will be more or less of a constructive character and will attempt to discover ways and means to prevent, or at least to minimize, the damage.

Two, more or less complete surveys were made of the Valley: one immediately and the second about two weeks after the heavy rain in October last. These surveys furnish some very interesting data regarding the susceptibility to and, in the case of some varieties, the entire immunity from damage from rain.

Generally speaking, though there are exceptions which will be noted later, the degree of damage depended very largely upon the condition of ripeness of the berry. The green or sugarless date and the perfectly ripe or matured date suffered the least injury whereas the berry in the intermediate stage of ripeness suffered very severely and in some cases was rendered unmerchantable and valueless. In every case observed by the writer the Itema, no matter what stage of ripeness or unripeness the berry might be in, was rendered unmerchantable, owing no doubt to the extremely rick sticky consistency of the date. Some growers may take exception to the findings and may contend that the damage to the ripe date, particularly in the case of the Khadhrawi, was quite as great as was the damage to the berry in the intermediate stage of ripeness, but, I believe, that careful investigation will show that in all of such cases the berry had been allowed to hang on the palm until it had passed the stage of perfect maturity and was therefore in an over-ripe condition.

The following is a report received from the Valley Packing Corporation regarding the condition of the ripe dates of different varieties received by it after the rain. The Khadhrawi is not included as all of that variety were picked and packed before the rain occurred.

Dubaini — condition improved by rain; skin softened, no damage.

Barhi — condition improved by the rain as more moisture.

Zahidi—condition improved by the rain as more moisture.

Asharasi—not damaged in any way.
Maktum—not damaged in any way.
Khalasa—not damaged in any way.
Tabirzal—not damaged in any way.
Halawi—not damaged in any way.

Bread dates and semi-bread dates not injured in any way.

Khastawi—puffy and sour.

Deglet Nur—very bad split and rot.

Arishti — very bad condition with broken skin.

Tafazwin—very bad condition with broken skin.

Yatima — very bad condition with broken skin.

Some growers had bagged the Deglet Nur dates prior to the rain, using waterproof paraffin paper bags in most cases and in some merely newspapers of many thicknesses. The dates which were properly protected from the rain by means of the waterproof bags or newspapers suffered practically no damage whereas those which were left exposed suffered injury varying in extent, depending upon condition of ripeness, from 20% to 80% with an average loss throughout the Valley of from 40% to 50%. One grower claimed that he had saved his Deglet Nur dates by means of burlap sacks, but these particular dates were practically all ready for picking prior to the rain and in the opinion of the writer the dates were rendered immune from damage in consequence of their ripened condition and really in spite of the fact that they were incased in burlap sacks which had a tendency to prevent the berries from drying out and thus being restored to their normal condition.

In all probability, judging from last season's experience, the Deglet Nur date can be saved by proper bagging from rain damage or injury, but, when using paraffin bags, care must be exercised to prevent injury o the stem and fruit strands from sun burning, which, when it occurs, causes the fruit to mummify and dry up. This may raise a controversial point as to whether the damage to the stem and fruit threads is sun burn or some other disease, and also whether it is the result of bagging or not. The weight of evidence appears to the writer to be in favor of the view first stated.

Some growers in the case of unprotected Deglet Nur dates shook the injured berries from the bunch and thus afforded opportunity to the undamaged berries to dry out and ripen without coming in contact with the injured berries. This was quite an expensive operation and it is a moot point as to whether it was effective in its action or not.

DISCUSSION

Geo. Swann: It is quite usual to use burlap sacks to protect the date palms from rain. At one time we covered about 53 female palms. We found that of these 53 palms 15% were undoubtedly affected some by the rain, but not much. In Imperial Valley on October 4th there was a very heavy rain. The sun came out the next day and dried things out and very little damage was done. On November 24th there was a light rain, but it stayed humid for a long time and the loss from this rain was very heavy. The damage resulted from fermentation, molding, splitting, etc. We have talked with some growers who state that they have used paraffin paper sacks and had good results, but we used cloth bags. Less than 5% of the dates so covered were damaged by the rain, so that it would soon repay the growers for the expense of buying these bags. We can say that we think that from our experience we could easily have averted the heavy loss to our crop from rain, if we had used more bags.

Question: To what extent were the bags closed?

Answer: Bags were completely closed before the rain, and then taken off after the rain.

Experiments With Selected Pollens

By Roy W. Nixon, Junior Horticulturist, U. S. Department of Agriculture

THAT pollen influences the fruit of the date palm has long been suspected, but so far the results of careful experiments which might be considered upon their own merits have not been available and opinions generally have been various and by no means conclusive. To secure such data the writer at the direction of Dr. Walter T. Swingle began a series of experiments in February, 1925, at the U. S. Experiment Date Garden, Indio, California.

Six pollens were selected which seemed most likely to have different influences upon the resulting fruit. These were from the following males, all seedlings of the varieties named and growing at the Indio station with two exceptions as noted.

Fard, No. 4.

Deglet Noor, Read No. 6.

"Government No. 1," a male grown from seed of uncertain parentage.

"Mosque," so-called after the local name of the parent palm, a superior specimen seedling discovered by Prof. S. C. Mason in Egypt. This is a very vigorous palm and produces an abundance of pollen in spathes nearly twice as large as those of any other male at the station.

"Huey," pollen sent by Mr. Laurence M. Huey from Bard, California.

Phoenix canariensis, the well-known ornamental Canary Island palm. This pollen was secured from a palm in Imperial valley.

Four female palms were used in the experiments: two Deglet Noor 14 years old; one Deglet Noor 13 years old; and one Deglet Noor seedling approximately 13 years old.

It was decided at the outset that comparisons would be justified only when the pollinations were made within a short range of time and on the same palm. There are apt to be differences between fruit produced on different palms of the same variety and even on the same palm to some extent between different bunches, especially as between early and late blooms. With this in view eight different experiments were made. The "Mosque" and Fard pollens were included in all of them; "Government No. 1" in four; Deglet Noor, Read No. 6 in two; "Huey" in two; Phoenix canariensis in six; and in five there were also unpollinated treatments—that is the flowers were bagged like the others but without the application of any pollen as a check on the efficiency of bagging.

Commercial pollination is a simple operation, but where two or more males are to be compared special precautions must be taken from beginning to end to make sure that the dates set are actually produced by the pollen to be tested. Anyone familiar with date pollen will readily understand the necessity for this. Individual pollen grains are so small

as to be almost invisible to the naked eye and are easily carried long distances by air currents to say nothing of insects and human clothing. The results of any experiments with date pollen are reliable only in proportion to the care that is taken in every detail from beginning to end.

While conducting these experiments, in order to minimize the danger of contamination from pollen blown about in the air or transported by bees no spathes were allowed to mature on any males except those designated, the others being cut from the palms before opening and while still immature. The males used in these experiments were visited early every morning and mature spathes cut as soon as they showed signs of splitting or opening. Each pollen was kept in a separate room reached from a different entrance. After handling one pollen, whether cutting for storage or using for pollination, the operator was very careful to wash hands and face and change clothing exposed. Precautions were also taken with all implements used.

It is difficult to bag satisfactorily an entire cluster of female flowers. When the spathe first begins to split the basal flowers are usually still far down in the axil of the leaf. Fortunately the early spathes of the Deglet Noor are much longer and narrower than those of most other varieties. To cover these spathes long narrow paper bags were made of ordinary brown wrapping paper, double thickness, sealed twice—essentially two bags, one within the other.

A close watch was kept on the growing spathes of the female palms and each bloom was pollinated as soon as the slightest tendency to crack or open was discovered. In pollinating a band of cotton was first tied around the base of the spathe as far down in the axil of the leaf as possible. The sides of the spathe were then pulled apart and pollen applied on small pieces of cotton about the size of a walnut, three or four being placed at different elevations between the strands. After the sharp edges were trimmed the spathe itself was left to give rigidity to the bag which was placed over all and tied firmly to the band of cotton at the base. Then a second band of cotton was tied around the outside at the base of the bag and as far down into the axil of the leaf as it was possible to push it. The bags were examined from time to time and during the first two weeks the base with its exterior band of cotton pushed farther down whenever necessary because of the elongation of the spathe.

Even at best there are apt to be minor variations between the fruit of different bunches on the same palm due to difference in exposure, time of blooming, etc. Hence for comparison it was very desirable to have the different pollens on the same bunch. In three of the eight experiments, the "Mosque," Fard, "Government No. 1," and Canariensis pollens were applied to the same bunch as follows: Before any pollen was applied sets of three strands each were chosen and enclosed in long narrow bags made specially for the purpose. As additional protection the entire bunch was then enclosed in a canvas hood. In pollinating, one bag was removed from under the canvas hood; the bag taken off; pollen applied to all the flowers with a piece of cotton using a superabundance of pollen; then the strands were rebagged and left outside the canvas hood until the next pollination, or about two hours, some such interval being considered desirable to permit wind or breeze to remove pollen which might remain in suspension in the air about the bunch.

The bags were left on from four to six weeks. A good set of fruit was obtained in all of the pollinations except the Canariensis which were a little below normal. The Fard sets averaged a little less than the "Mosque," Deglet Noor Read No. 6 and "Government No. 1," but the difference would not have attracted attention in a commercial garden.

The precautions taken in carrying out these experiments are believed to have resulted in a nearly maximum purity of pollination. Unpollinated checks indicated that the methods of bagging used afforded 97% to 100% insulation. A further check on the purity of the pollinations was afforded by the seed resulting from Canariensis pollen, which were found not only to be smaller than any other but also to possess a characteristic tapering toward the basal end, making it possible to distinguish seed which probably resulted from other pollen. The two indexes agreed except in one Canariensis pollination where 10% of the seed were found to be off-type. On the other hand, as further evidence of the care taken in handling the different pollens, in all of the other pollinations no seed appeared which resembled those of the Canariensis. Furthermore the results of these experiments were very consistent one with another.

By the middle of June the pollinated dates averaged about 20 to 25 millimeters (4-5 to 1 in.), while the unpollinated dates, 'tho developing largely as single dates as is common in the Deglet Noor variety rather than the 2's and 3's characteristic of many other varieties, were only half this size. It was also evident at this time that the dates of the Canariensis pollinations were slightly smaller than those of the other pollinations.

By the middle of July the bulk of the Deglet Noor dates in the Coachella Valley have usually reached their maximum size and begin to change in color from green to a bright coral red which is characteristic of the pre-ripe stage in this variety. During the period of color change every shade from pure green to bright red may be found at the same time on the same bunch and often on the same date. However, differences in the rate at which the several pollinations took on the red color were very apparent. In fact the earlier coloring of the Fard pollinations was one of the striking features of these tests and the first intimation of any difference in ripening due to pollen. It was noticeable in every experiment, but was especially obvious in the three where all the pollinations were side by side on the same bunch. This difference in coloring was followed by a corresponding difference in ripening. In every experiment dates produced by the Fard pollen ripened earlier than any of the others. In the three where all of the pollens were on the same bunch the relative maturity of the dates was determined by actual count as follows:

RELATIVE MATURITY OF DATES IN THREE EXPERIMENTS, EACH HAVING THE DIFFERENT POLLENS ON THE SAME BUNCH

Exp.	Pollen	Total	Ripe	Part Ripe	Not Ripe	% Ripe & Part Ripe	Total	Ripe	Part Ripe	Not Ripe	% Ripe & Part Ripe
		Aug. 18					Aug. 27				
No. 1	Fard	57	18	5	34	40.3	57	37	10	10	82.5
	"Mosque"	104	0	7	97	6.7	104	9	8	87	16.3
	"Gov. No. 1"	124	0	5	119	4.0	124	12	5	107	13.7
	Canariensis	77	2	0	75	2.6	77	5	2	70	9.1
		Aug. 18					Aug. 27				
No. 2	Fard	79	4	0	75	5.1	79	11	2	66	16.5
	"Mosque"	127	0	0	127	0.0	127	3	0	124	2.4
	"Gov. No. 1"	122	0	0	122	0.0	122	4	3	115	5.7
	Canariensis	49	0	0	49	0.0	49	0	0	49	0.0
		Aug. 18					Sept. 16				
No. 3	Fard	84	8	10	66	21.4	84	84	0	0	100.0
	"Mosque"	69	0	0	69	0.0	69	43	0	26	62.3
	"Gov. No. 1"	124	0	0	124	0.0	124	80	7	37	70.2
	Canariensis	63	0	0	63	0.0	63	30	0	33	47.6

In the single experiment on the Deglet Noor seedling with only the Fard and "Mosque" pollens seasonal notes only were made as to the relative rate of ripening, but the Fard was obviously earlier. In the other four experiments weekly pickings were made beginning August 27th, from which the following summary is tabulated. None of these bunches were pruned or thinned in any manner.

RELATIVE MATURITY OF DATES IN FOUR EXPERIMENTS, EACH HAVING THE DIFFERENT POLLENS ON SEPARATE BUNCHES

Experiment	Pollen	Date Pollinated	Total Production	% Ripened by Sept. 30
No. 1	Fard	2-23	464 oz.	97.4
	"Mosque"	3-2	773 "	59.1
	Deglet, Read No. 6	2-27	694 "	72.7
	Canariensis	2-25	303 "	74.9
No. 2	Fard	2-26	530 "	92.0
	"Mosque"	2-25	454 "	87.4
	Deglet, Read No. 6	2-26	671 "	71.5
	Canariensis	2-24	479 "	64.0
No. 3	Fard	3-19	323 "	69.3
	"Mosque"	3-23	207 "	53.1
	"Government No. 1"	3-12	433 "	46.6
	Canariensis	4-10	58 "	17.2
	"Huey"	3-30	156 "	38.4
No. 4	Fard	3-22	362 "	82.8
	"Mosque"	3-21	645 "	48.5
	"Huey"	3-26	248 "	51.6

The high percentage for the "Mosque" in Experiment No. 2, inconsistent as it is with the results in the other three, is explained by the fact that this bunch ripened abnormally due to the stalk having been partially broken at the base by a heavy windstorm the latter part of August. That this caused excessive shrivelling and prematuring was obvious at the time and a high percentage of low grade fruit showed up in all the pickings. The Canariensis pollination in Experiment No. 3 represents the last bloom which appeared on the palm and consequently it was much smaller and about half of the fruit on this bunch was lost from rot.

The fruit which was damaged by the rain of October 4th and 5th was all picked, weighed and included in the record. The weights were found to be about 20% heavier than for an equal number of ripe dates, but this was believed to be more than offset by the proportion which fell to the ground before it could be picked. The loss from the soft rot which began to develop later in October was not entered in the record. Much of the rotting fruit fell to the ground from day to day and no attempt was made to weigh any of it. However, the loss from this source was very slight except in Experiment No. 3 (of the series having the pollens on separate punches). Most of the Fard fruit in all of the experiments had already been picked so there was practically no effect on it whatever. Taking this into consideration it is evident that in a normal season the actual percentage of total fruit ripening in September would probably have been less for all of these pollinations except the Fard.

From the behavior of the pollinations in those experiments least affected by adverse conditions it appeared that the actual difference in time of ripening between the Fard and the "Mosque" was about ten days for the first half of the crop and three weeks for the last half, the ripening of the "Mosque" being prolonged as the season advanced.

To compare the size, millimeter measurements were made in each pollination of the length and breadth of fruit and seed of 100 ripe fruits, representing not less than four different pickings between Sept. 1st and October 15th. In the three experiments each having the different pollens on the same bunch a lesser number of fruit than 100 was available, but the maximum number of measurements possible was obtained, these being made at the same time. From these measurements the two most diverse dactylifera pollens were found to be the "Mosque" and the Fard, the former producing larger fruit and seed in every experiment. "Huey" pollen gave results comparable to the "Mosque," while Government No. 1 and Deglet Noor, Read No. 6, were slightly smaller.

From the standpoint of biometric comparison, however, the results of the "Mosque" and the Fard pollinations are sufficient evidence of the effect of pollen on the size of both fruit and seed. The average lengths of fruit and seed afford the best basis for comparison. The breadth measurements showed variations in the same direction tho on a much smaller scale and less pronounced in the fruit than in the seed. The average lengths of seed in the experiment showing the least difference were, "Mosque," 24.3 mm. and Fard, 22.8 mm; in the one showing the greatest difference, "Mosque," 28.3 mm. and Fard, 23.9 mm. A critical examination of the nearest approach gives a difference of 1.5 plus or minus .28 mm .This difference is more than three times the probable error and must be considered of biometric significance.

Considering the average lengths of fruit in the same manner, the "Mosque" and the Fard ranged from 38.7 mm. and 38.4 mm. respectively in the experiments showing the least difference to 45.9 mm. and 40.8 mm. respectively in the experiment showing the greatest difference. In the former, the difference is obviously too small to be significant. Since the experiment showing the greatest difference in size of fruit was on the Deglet Noor seedling, it is of interest to take the next range within these limits, which represents all Deglet fruit and which was 40.9 mm. and 39.3 mm. to 44.9 mm. and 40.9 mm. for the "Mosque" and Fard respectively in each case. A critical examination of the first, which is the second nearest approach of the averages of fruit measurements, gives a difference of 1.6 plus or minus .16 mm., which is of biometric significance.

Hence in every one of the eight different experiments there was a significant difference in the size of the seed produced by these two pollens; in seven of them a significant difference in the size of the fruit with the difference in the eighth still varying in the same direction. The variation in the fruit was proportionately less than in the seed. It will be recalled that pollen of Phoenix canariensis produced fruit and seed even small than the Fard and in addition the seed from this pollen had a distinct shape, tapering noticeably toward the basal end. Along with this the data already given showed a marked difference in the time of ripening of the Fard pollinations in every experiment.

The possibility of being able to influence the time of ripening by the use of selected pollens may be of vast importance in the development of the date industry in new regions. In fact where the seasonal margins are rather sharply defined a few weeks difference in time of ripening might be the difference between success and failure with certain varieties.

It may be that within certain limits differences in the quality of the fruit may be traceable to pollen. Many observers believe this already, but convincing evidence is not yet available. Some differences appeared in these experiments, yet their occurence was not sufficiently uniform, due in part possibly to the abnormal season, to justify any report at this time. The conditions prevailing udring the latter part of the ripening season also interrupted plans to obtain data on the proportionate relative weights of fruit and seed produced by the several pollens, but while the evidence secured is insufficient to be conclusive, it should be stated that in such observations as were made the chief difference appeared to be in the seed without a proportionate difference in the weight of the flesh. These experiments are being continued. Meanwhile in considering the subject as a whole a word of caution may be unnecessary, but at this formative stage in the development of the date industry, when fundamental cultural practices such as fertilization, irrigation, thinning of fruit, etc., have not yet been subjected to intensive study, it would be most unwise to overemphasize the importance of pollen. The results of these investigations thus far certainly indicate that within certain limits the fruit may be affected by the pollen, yet fine distinctions are involved and further study is needed to determine the nature and extent of this influence. This is a field in which very little research has been done with any fruits. But by definitely associating certain differences with pollen, the way is paved for an intelligent approach to the problem.

It must be borne in mind that practically all the male palms now available are seedlings and they may be expected to show all the variability only too well known in the case of female seedlings. This means that at present it is impossible to predict the behavior of any one male. The fruit produced by each pollen will have to be carefully studied and compared with that produced by other pollens.

However, most growers have a few males on which they depend more than any others because they have found from experience that they could count on a good seasonal supply of pollen known to produce satisfactory sets of dates. It is believed that growers will find it well worth while to make a few careful pollination tests with such males each season. Offshoots of promising males especially should be carefully preserved. It is not likely that many will be found to be of exceptional character, but this is another reason why the good of the industry will be furthered by the full co-operation of all in gradually weeding out of the many hundreds of scattered males a few desirable ones which may in time be the source of dependable strains of known quality.

Rainfall Data

Prof. S. C. Mason

IT is of course important to know something about the rainfall in the date growing regions, especially those rains which occur during the period of time when dates are matured.

We have of course many local showers; for instance some of our neighbors on the west side of the Coachella Valley may have quite a rain while the people in Indio have no record at all. Mr. Drummond's reports show that sometimes there will be a rain coming down in a torrent four or five miles from Indio while at Indio there was no storm indications at all.

The main question is whether the mean rainfall month by month is great enough to amount to any danger; whether these rains occur at a time when dates are ripe, and whether the growers will have to get out policies to insure their date crops. Also how great is the percentage of risk if we take the months of September and October for the entire 28 years recorded.

A study of the records, as shown in the table and chart, would seem to give a risk of one to three we might say. This would mean that a man has to defend himself from rain one year out of every three year. The date grower should consider what he is to do about it—whether he is to throw burlap sacks over his dates or what?

What we need is more data from our date growing regions, then we can expect more progress in the future. In Arizona, August is the dangerous month so it seems that we should there try to provide dates that will not be hurt by the rain at that time.

Question: Do you think that the increased irrigation will affect dates?

Answer: I still question whether it will or not. It is possible that the increased irrigation both in Coachella Valley and in Imperial Valley may have something to do with the date industry.

TABLE COMPILED FROM U. S. WEATHER BUREAU RECORDS

Showing Rainfall at Indio at Critical Periods for the Date Crop from 1877 to 1925 Inclusive in Inches and Hundredths.

Year	Aug.	Sept.	Oct.	Nov.
1877				
1882				1.0
1885				.90
1888				1.10
1889	.95			
1891	1.16			
1893	.75			
1897		2.10		
1900			1.04	
1905				1.06
1906	1.07			
1907			1.06	
1908		1.60		
1909	.87	1.12		
1912			1.90	
1913		.40		
1916		.72		
1919		1.50		
1920	3.61			
1921*	.72	1.24		
1923*	1.85 at Mecca			
1923*	.21 at Indio			
1925*		4th - 1.52		
		5th - 1.22		

*From U. S. Government Date Garden records.

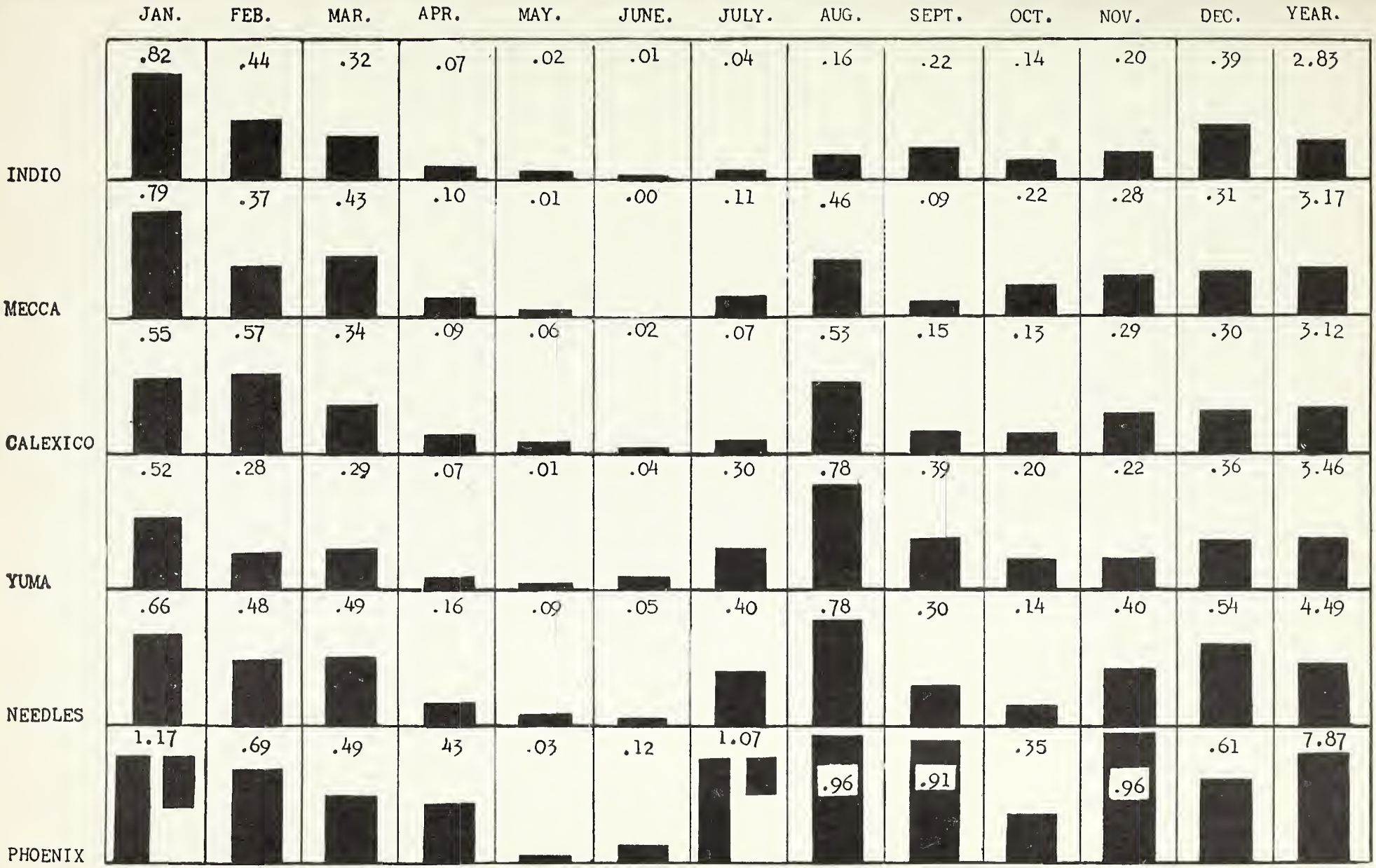

Diagram of Mean Monthly Rainfall in Hundredths of an Inch, Drawn to Actual Scale, at Six Stations in theDate Growing Regions of Arizona and California. At Right Annual Rainfall, Scale .1 Inch Equals 1 Inch.